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Combinations of support instruments for renewable electricity in Europe: A review

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ABSTRACT

The aim of this paper is to review the combinations of RES-E support instruments in the European Union (EU), using different sources of data. It is shown that combinations are indeed a widespread phenomenon in the EU Member States. Not much attention has been paid to the combinations of primary instruments with other secondary instruments for the same renewable energy technology. It is found that the most frequent mixes of instruments are between feed-in laws (feed-in tariffs, and increasingly feed-in premiums), on the one hand, and investment subsidies, soft loans and tax incentives on the other. In a broad sense, the policy mix between primary and secondary instruments has experienced some changes over the last decade, mostly related to changes in the primary instruments themselves. Exclusion (i.e., ineligibility to apply for an instrument when the RES-E generator is already being financially supported by another instrument) and explicit coordination of support under primary and secondary instruments do not seem to be common elements in these policy combinations.

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1. Introduction

The abundant literature on support schemes for electricity from renewable energy sources (RES-E) has mostly focused on the comparison between two primary instruments: feed-in laws and quotas with tradable green certificates (TGCs) (see [1] for a review). It is widely recognised now that this debate is outdated and that the success of policies for RES-E support depends as much on the instrument chosen as on the design details of instruments and the context of their implementation [2,3]. In addition, the combinations, for the same technology, of those primary instruments with other secondary instruments (including investment subsidies, soft loans and fiscal incentives) have not received a comparable attention. This topic is certainly not analysed in highly relevant policy documents such as the policy chapter in the Intergovernmental Panel on Climate Change (IPPC) Report on Climate Change and Renewables [4], the International Energy Agency (IEA) Report on Policies for Renewables [5] or the European Commission guidance for the design of renewables support schemes [6]. Ref. [7] provides a graphical analysis of the advantages of combining different instruments and represents an exception in this context.

This lack of analysis of instrument combinations occurs despite the fact that most countries with renewable energy policies around the world have implemented more than one type of instrument [8,9]. In the EU, RES-E deployment instruments are combined either across technologies or for the same technology (see Section 3). How to

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combine RES-E support instruments in order to promote the deployment of RES-E cost-effectively is a relevant issue for governments, at least in the European Union (EU), where targets for the penetration of renewable energy in energy consumption have been set for 2020. According to Directive 28/2009/EC [10], renewable energy should contribute to 20% of energy consumption in the EU in 2020. The recent communication from the Commission on January 22nd 2014 proposes a 27% renewable energy target for 2030 [11]. In addition, it is a relevant issue for the EU itself. In the recent European Commission Guidelines on State aid for environmental protection and energy 2014–2020, it is stated that "aid may be awarded concurrently under several aid schemes or cumulated with ad hoc aid, provided that the total amount of State aid for an activity or project does not exceed the limits fixed by the aid ceilings laid down in these Guidelines" [12]; p. 27, number 81. The aim of this paper is to review the combinations of those instruments in the EU Member States (MS), using different sources of data.

Combinations of instruments can be justified to account for the coexistence of market failures and/or barriers to achieve certain policy goals. If there are multiple market failures to the uptake of RES-E, combinations of instruments would make sense if a single instrument cannot tackle all those failures simultaneously and each failure can only be appropriately addressed by one instrument [4,13–15]. This follows Tinbergen's dictum that multiple market failures require multiple instruments [8]. In the real world, however, the combination of instruments might also be related to political economy factors, i.e. to the influence of a given stakeholder group [16].

The analysis of combinations of instruments has been the focus of much research in the climate and energy policy literature (see, e.g., [14,15,17] for reviews). These combinations have been investigated for the same technology over time (i.e., sequentially) as well as simultaneously for different technologies but, as mentioned above, not simultaneously for the same technology. Following the above-mentioned justification, the literature generally supports the combination of several instruments.

The combination of primary instruments with secondary instruments could be regarded as an attractive option by policy-makers in order to promote RES-E effectively and efficiently. An instrument is said to be effective if it is able to achieve a significant RES-E deployment or a certain RES-E target [1]. Cost-effectiveness refers to the achievement of a given RES-E target at the lowest possible cost to society.

Combinations of instruments have often been justified based on the effectiveness criterion [18]. For example, while FITs provide a stable revenue flow for investors, and have proven very effective to trigger RES-E investments, investment subsidies and soft loans may further encourage investments by reducing the costs of financing, which might be a main barrier to the deployment of RETs [19]. This is because investment-related costs represent the main electricity generation costs for RETs. Their relatively high capital-intensity leads to high funding requirements. However, combinations of instruments may also lead to conflicts, resulting in inefficiencies, redundancies, double coverage or double counting [20]. It is not the aim of this paper to analyse the advantages and drawbacks of instrument combinations, neither in general nor for specific countries but to identify how primary and secondary instruments have been combined in the EU MS.

Accordingly, this paper is structured as follows. Section 2 describes the main instruments for RES-E support used in the EU. An overview and discussion of those combinations in the EU Member States are provided in Section 3. Section 4 concludes.

2. Primary vs. secondary instruments

RES-E deployment promotion has traditionally been based on three main (primary) mechanisms, whose costs are usually borne by consumers: feed-in laws, quotas with TGCs and tendering (see [3,7,21] for further details). The classical distinction between primary and secondary instruments is a widespread one in the RES-E support literature, although with different names, "dominating instruments" in [22], "main support schemes" in [23–25] and "primary" and "secondary" instruments in [7,21,26,27]. This distinction is made in order to differentiate instruments which are the basis (the main economic incentive) for RES-E support in some countries. Most RES-E investments in EU countries have been triggered by feed-in laws or quotas with TGCs, whereas other instruments have played a minor role, with some exceptions.[1]

- *Feed-in laws* provide for preferential prices per kWh (or MWh) of RES-E generated, paid in the form of guaranteed premium prices and combined with a purchase obligation by the utilities. Feed-in tariffs (FITs) provide total payments per kWh of electricity of renewable origin, whereas a payment per kWh on top of the electricity wholesale-market price is granted under feed-in premiums (FIPs) [28]. Feed-in laws are applied in 23 EU countries.
- *TGCs* are certificates that can be sold in the market, allowing RES-E generators to obtain revenue. This is additional to the revenue from their sales of electricity fed into the grid. Therefore, RES-E generators benefit from two streams of revenue from two different markets: the market price of electricity plus the market price of TGCs multiplied by the number of MWh of renewable electricity fed into the grid. The issuing (supply) of TGCs takes place for every MWh of RES-E, while demand generally originates from an obligation. Electricity distribution companies must surrender a number of TGCs as a share of their annual sales or pay a penalty. The TGC price covers the gap between the marginal cost of renewable electricity generation at the quota level and the price of electricity. Quotas with TGCs are used in 6 EU countries (U.K., Sweden, Belgium, Italy, Romania and Poland), with two of them partially using FITs (Italy and U.K.)
- *Tendering*. The government invites RES-E generators to compete for either a certain financial budget or a certain RES-E generation capacity. Defined technologically neutral or within a given technology band, the cheapest bids per kWh are awarded contracts and receive the subsidy. The operator pays the bid price per kWh. In the EU, tendering is currently used in 9 countries (Bulgaria, Hungary, Malta, Lithuania, Latvia, Italy, Portugal, France and Denmark).
- *Net metering* refers to a regulated arrangement in which utility customers who have installed their own generation systems pay only for the net electricity delivered from the utility (total consumption minus on-site self-generation) [29]. Net metering is currently used in 3 EU countries (Denmark, Italy and the Netherlands), generally as a primary instrument.

Several secondary instruments have been combined with the former in the past, including

- *Investment subsidies*. They are granted in the beginning of the project lifetime and can be calculated as a percentage of the renewable energy output or the specific investment cost, although this latter version is more common. Investments grants for RES-E are available in many EU Member States (MS).
- *Soft loans* are usually provided by governments with a rate below the market interest rate. In some cases, they can significantly reduce the costs of capital. Soft loans may also

[1] This description of instruments is based on [1,18,21].

provide longer repayment periods or interest holidays. In short, they involve more favourable conditions for borrowers.
- *Fiscal incentives* can be exemptions or rebates on (energy, corporate or income) taxes, tax refunds, lower VAT rates or attractive depreciation schemes.

In contrast to primary instruments, which generally cover all RES-E installations and are set at the national level, secondary instruments are usually limited in scope and circumscribed to specific types of projects (e.g., small ones) and technologies (e.g., solar PV). Whereas main instruments are almost always applied at the national level, secondary ones are applied at both the national and lower government levels, that is, regional/provincial/municipal.

3. The policy combinations in the EU

Several sources with updated information on the RES-E support schemes implemented in EU countries have been used in order to identify policy combinations for RES-E support in the EU. They include the Eurobserver database [30], the RES legal database [31], the Beyond 2020 project [1], the Council of European Energy Regulators [32] and the IEA/IRENA Joint Policies and Measures database [25]. The data provided for each country have been systematically compared between documents. They generally agree on the type of instrument being applied in each Member State. The few discrepancies have been resolved by using secondary sources of data (i.e., country case studies from other sources), if available, and consulting energy experts in those countries.

In addition, the current trends (i.e., changes) in combinations of instruments over the last few years have been identified. Reports from REN21 in several years (2005, 2009 and 2013) have been used [9,33,34]. According to the IPCC Special Report on Renewable Energy [4], REN21 is believed to be the only source that tracks renewable energy policies annually on a global and comprehensive basis. Those reports provide information on the implementation of instruments in countries all over the world. Therefore, their 2005, 2009 and 2013 editions allow us to identify the evolution of combinations of instruments over time. In addition, the IEA/IRENA Joint Policies and Measures database provides details on the trends RES-E policies [25]. Reports from several EU-funded projects have also been used, including ADMIRE-REBUS [35], GREEN-X [7], OPTRES [3], RE-SHAPING [24] and BEYOND 2020 [1]. These reports provide information about the instruments being applied in the Member States and, thus, about their combination. Table 1 summarises the results of our assessment, providing details of instrument combinations in the EU. Table 2 provides a comparative overview of primary and secondary instruments per country.

Tables 1 and 2 show that combinations are indeed a widespread phenomenon in the EU Member States. All countries use a primary instrument (generally feed-in laws, either FITs or FIPs) and secondary instruments. This is related to the fact that feed-in laws are the most common primary instrument in the EU. FITs/FIPs are combined with investment subsidies in 18 countries, with soft loans in 8 countries and with fiscal incentives in 13 countries. Quotas with TGCs are combined with investment subsidies in four countries, with soft loans in one country and with fiscal incentives in five countries. Notwithstanding, there are major differences in the details of those combinations across countries.

An appropriate design of the instrument mix, i.e. coordination between instruments, is crucial in order to make sure that RES-E producers are not overcompensated and that an excessive financial burden does not fall on consumers or taxpayers. Explicit coordination can be understood in this context as setting remuneration levels under one (primary) instrument, taking the support levels provided by another (secondary) instrument into account [18]. Explicit coordination can be observed only in a few countries. In Greece, FITs would increase by 15–20% in case the RES-E plant does not receive capital grants [36]. If investment subsidies from Structural Funds are added to the FIT, the FIT period is reduced in Hungary. The FIP is reduced if the RES-E producer receives investment subsidies in Slovakia and Slovenia [37]. Coordination exists for small solar PV projects in Cyprus. When these projects do not apply for an investment subsidy, the FIT is much higher (38.3 vs. 22.5€ cents/kWh). If a plant is supported under another government-funded programme in Romania, the number of TGCs to be issued is set by the regulatory authority on a case-to-case basis. Therefore, explicit coordination between deployment instruments seems to be quite exceptional in the Member States.[2]

Exclusion refers to the ineligibility to apply for the support provided by an instrument when the RES-E generator is already being financially supported by another instrument. Exclusion is not a common element in these policy combinations either. There are some exceptions. In Austria, FITs and investment subsidies work as alternative instruments. In Flanders, technologies supported with TGCs are excluded from investment subsidies. FIT support cannot be accumulated for large projects in Cyprus with investment subsidies from either European or national funding. In Estonia, the investment subsidy is provided through the Green Investment Scheme for wind energy and it is alternative to the FIP: RES-E generators that receive it are not eligible for the premium. In Greece, solar PV plants receiving the FIT cannot enjoy the investment subsidy. In Italy, the FIT is alternative to TGCs for systems with installed capacity lower than 1 MW, which can participate in the FIT. In Lithuania, the tender is alternative to the FIT.

The policy mix between primary and secondary instruments has experienced some changes over the last decade in several respects. First, different primary instruments have recently been integrated. Quotas in the form of capacity caps have been implemented in FITs, tenders are used sometimes to set support levels in feed-in laws[3] and minimum and maximum prices in TGC schemes make them look like FITs to some extent. Second, changes between primary instruments can also be observed in recent times. More specifically, there have been shifts from FITs to FIPs and from FITs to tenders. Third, instruments have been combined for different technologies. In countries with quotas with TGCs, FITs or FIPs have been used as alternative systems for specific technologies (solar PV) or small projects (as in Italy and U.K.). Finally, there has been some convergence between countries at the level of design elements. For example, countries with FITs have increasingly used cost-containment mechanisms, including capacity caps (e.g., Spain, Germany, Ireland, Lithuania, Portugal and Slovenia, among others) and budget caps (e.g., the Netherlands, Italy and Estonia).

An analysis of the evolution of RES-E support instruments in the EU Member States since 2005 (Table 3) reveals that, with the exception of RPS with TGCs, the use of instruments has experienced an increase in the first subperiod (2005–2009), and a reduction in the second subperiod (2009–2013). The economic and financial crisis may have induced a reduction in the number of instruments, in order to reduce the burden on consumers and taxpayers. The fact that fiscal incentives have experienced the greatest reduction in the second sub-period seems to confirm this interpretation. This is the instrument most related to the public budget and, thus, the one most possibly affected by austerity policies. The increase in the use of tenders during the whole

[2] Obviously, governments may set the support level under one instrument taking the support levels of other instruments into account. Information on such "implicit" coordination is not publicly available, however.

[3] Tenders have also been used in FITs to allocate the procurement right (as in Latvia), rather than to set the support level.

Table 1
Instrument combinations for RES-E deployment support in EU countries.
Source: Own elaboration from Reshaping Project [24], Eurobserver database [30], RES legal database [31], Beyond 2020 project [1], the Council of European Energy Regulators [32] and IEA/IRENA Joint Policies and Measures database [25].

Country	Primary instrument	Secondary instruments	Remarks
Austria	• FIT (AT exc. SH and PV <5 kW) • Inv. subsidies (only PV <5 kW, Climate and Energy Fund)		FITs and investment subsidies work as alternative instruments.
Belgium	Quotas with TGCs (AT)	• Tax deductions (AT) • Inv. subsidies (Brussels, W, H, B) • Inv. subsidies (Flanders, PV)	• The quota with TGCs instrument is a federal instrument applied at the regional level. Minimum TGC prices are determined by Flanders and Wallonia, except for offshore wind, determined at federal level. • Inv. subsidies in Brussels available only for households and the services and industrial sectors. • In Flanders, technologies supported with TGCs are excluded from Inv. subsidies (alternative instrument).
Bulgaria	• FIT (AT) • Tender (PV >100 kWp)	Soft loans (AT, small projects only)	The soft loan are grants up to 15% of the disbursed loan.
Cyprus	• FIT (AT, large projects) • FIT (AT, small projects)	Inv. subsidies	• Size thresholds: 30 kW (W), 20 kW (PV). • For large projects, FIT support cannot be cumulated with inv. subsidies from European or from national funding. • When there is no subsidy for small solar PV projects, the FIT is much higher (38.3 € cents/kWh vs. 22.5 € cents/kWh).
Czech Republic	FIT or premium (AT, exc large W farms >20 MW, on-ground PV and roof-top PV >30 kW)	Inv. subsidies and low interest loans (W)	PV is not eligible for inv. subsidies.
Denmark	• FIP (AT exc. WOF) • Tenders (WOF)	• Inv. subsidy for small RES-E systems (AT) • Loan guarantees (W) • Net metering (PV) • Tax relief (PV).	The loan guarantees are for local initiatives involving the erection of wind energy systems. However, the price per kWh has been given as a fixed settling price (market price+variable premium) by the state in the call for tenders.
Estonia	FIP (AT)	• Investment subsidy (W). • Exemption from elect. production tax	The investment subsidy is provided through the Green Investment Scheme for wind energy. It is alternative to the FIP: RES-E generators that receive it are not eligible for the premium.
Finland	FIP (W, Bg, B)	Inv. subsidies (AT, inc. PV).	The FIP for forest chips varies depending on the CO_2 emissions allowances. Subsidy is not paid if the price of allowances exceeds 23€.
France	Tenders (WOF, PV >100 kW on buildings and ground-mounted) FIT for the rest (inc. PV in buildings <100 kW)	Investment subsidies.	There is a maximum level of support for successful bidders. Whereas large-scale RES installations are mainly supported at national level, regional incentives aim at supporting smaller scale RES-E developments for private owners and local communities.
Germany	FIT/sliding FIP (AT)	Low interest loans (AT)	
Greece	FIT (AT)	Inv. subsidies or tax exemption (AT)	Solar PV plants receiving the FIT cannot enjoy the inv. subsidy.
Hungary	FIT (AT)	Inv. subsidy (AT)	Investment subsidies through Structural Funds. According to new legislation, new wind capacities can only be established in a tender procedure. A tender for the construction of 410 MW in wind farms was cancelled. The government reserved the right to reopen the tender process under new conditions, but when and how it is unclear. Projects receiving the Structural Fund subsidy see their FIT period reduced.
Ireland	FIT	Tax relief	
Italy	• Quotas with TGCs (existing plants)	• Reduced VAT rate	• Existing plants: plants entering into operation

Table 1 (*continued*)

Country	Primary instrument	Secondary instruments	Remarks
	• FIT (existing plants < 1 MW) • FIP (> 1 MW and < 1 MW which do not choose the FIT, exc. solar plants) • New plants: tenders for large projects • New plants: FIT for medium-size and small projects • Net metering		before 4/30/2013. • Alternative to TGCs for systems < 1 MW, which can participate in the FIT. • Net metering (PV < 20 kW). This is alternative to the FIT. • Size thresholds for tenders: > 5 MW, exc. hydro > 10 MW, geothermal > 20 MW. Booking by means of preregistration for medium and small size projects.
Latvia	FIT (AT)	• Investment subsidy • Tax exemptions from the electricity tax	The FIT is granted on the basis of a tender. The tender is only applied to earn the mandatory procurement right, not to set the support level. The calculation of the FIT is based on a formula. However, according to [24], in the period 2011–2015, the government does not organise any tenders for granting the right to sell RES-E from B, Bg, PV or W power plants and producers may not qualify for selling electricity under the mandatory procurement process.
Lithuania	• FIT (< 10 kWh, AT, except geothermal) • FIT/tender (> 10 kWh, AT, except geothermal) • Net metering (PV < 20 kW)	• Investment subsidies • Soft loans	Installed capacity > 10 kW is awarded through tenders. A tender is won by the participant offering the lowest FIT. The National Control Commission for Prices and Energy quarterly sets the maximum FIT for the subsequent tender procedures. This instrument is alternative to the FIT.
Luxembourg	FIT (AT)	Investment subsidies (AT)	Inv. subsidies are available for the use of RES-E in enterprises and for individuals installing solar PV.
Malta	FIT (PV)	• Investment subsidies (PV+W for households < 3.7 kW) • Soft loans • Tax credit on investment (PV)	The National energy policy for Malta of December 2012 proposes measures on renewable energy, including: (1) a feed-in tariff system for the installation of PV panels by the private sector which are not supported through other funding, providing between 16 and 18 cents per kWh; (2) a new call for tender to install PV panels on an additional 40,000 m^2 of public building rooftops; (3) a new scheme giving the option of a communal PV solution for small investors and for households who do not have access to a rooftop.
The Netherlands	FIP (PV > 15 kW) Net metering (PV < 15 kW)	• Soft loans (AT, exc. WOF) • Inv. subsidy (PV)	The annual FIP is equal to the base rate minus the electricity price (i.e., not fixed premium). The SDE+provides a FIP covering the difference between production costs and income (i.e. energy price). Installations are granted support according to the generation costs and on a first come first served basis. Least expensive technologies can apply for subsidies in a first place. More costly projects can apply for higher subsidies but only after the first round of allocation and if funding is left available in the annual budget. Therefore, the cheapest the technology the more likely it will be granted subsidies.
Poland	Quotas with TGCs (AT)	• Soft loans (AT) • Inv. subsidies (AT) • Exemption from electricity consumption tax (AT)	
Portugal	FITs (AT) Tenders	Tax relief	Tenders for solar PV and mini-hydro are used to allocate the right to connect to the grid, not to set the support level. In contrast, tenders for W and B are used to set the support level. On 31st December 2012 FIT rates for micro and mini renewable electricity generators were announced.
Romania	TGCs (AT)	Inv. subsidies (AT)	Investment subsidies refer to cofinancing of EU Structural Funds or by the National Energy Fund. If a plant is supported under another government-

Table 1 (*continued*)

Country	Primary instrument	Secondary instruments	Remarks
			funded programme, the number of TGCs to be issued is set by the regulatory authority on a case-to-case basis.
Slovakia	FIP (AT)	• Inv. subsidies (AT) • Exemption from electricity consumption tax (AT)	In the future, measures are proposed for PV plants with fluctuating production, which will operate on the reverse auction principle. The FIP is reduced if the RES producer receives inv. subsidies.
Slovenia	FIT/FIP (AT)	• Inv. subsidies (AT) • Low interest loans	Plants <5 MW can choose the FIT or the FIP. The FIP is only for plants >5 MW.
Spain	FIT/FIP (AT, existing plants before January 2012).	Tax relief	Sine die moratorium on support for new RES-E plants.
Sweden	Quota with TGCs (AT)	• Tax exemptions (B, W, peat and RES-E <100 kW) • Inv. subsidies (PV, large-scale WOF)	
U.K.	• Quota with TGC schemes • FITs (<5 MW)	Tax exemption (from the Climate Change Levy).	The existing Renewables Obligation (RO) will continue for existing projects supported by the scheme and new ones until March 31st 2017. Between 2011 and 2017 new renewable energy generators will have a one-off choice between RO support of feed-in tariff. From April 2010, plants <50 kW no longer qualify for support under the RO, but are instead eligible for support under the introduced FIT. A maximum size of 5 MW is set for projects to receive support under the FIT.

Notes: Instruments are applied at the national/federal level, unless otherwise stated. AT=the instrument is applied to all RETs; W=wind on-shore; WOF=wind off-shore; B=biomass; Bg=Biogas; SH=small hydro; PV=solar photovoltaic.

Table 2
Overview of instruments per country.
Source: Own elaboration.

	FIT	FIP	Quotas with TGCs	Tenders	Net metering	Tax deductions/exemption	Inv. subsidies	Soft loans
Austria	√						√	
Belgium			√			√	√	
Bulgaria	√			√				√
Cyprus	√						√	
Czech Republic	√	√					√	√
Denmark		√		√	√	√	√	√
Estonia		√				√	√	
Finland		√					√	
France	√			√			√	
Germany	√	√						√
Greece	√					√	√	
Hungary	√						√	
Ireland	√					√		
Italy	√	√	√	√	√	√		
Latvia	√					√	√	
Lithuania	√			√	√		√	√
Luxembourg	√						√	
Malta	√					√	√	√
The Netherlands		√			√		√	√
Poland			√			√	√	√
Portugal	√			√		√		
Romania			√				√	
Slovakia		√				√	√	
Slovenia	√	√					√	√
Spain	√	√				√		
Sweden			√			√	√	
U.K.	√		√			√		

period is likely to be related to the concern of governments about the asymmetric information problem in the setting of appropriate support levels in FITs and FIPs [38].

Based on information from REN21, there are some common patterns in the EU compared to non-EU high-income countries, although some differences can be observed (Table 4). Both EU and

Table 3
Evolution of RES-E support instruments in the EU countries (2005–2013).
Source: Adapted from REN21 [18,34,35].

	FIT and FIP	RPS with TGCs	Investment Subsidies	Investment excise or other tax credits	Loans	Tendering
2005	17	8	17	15	8	2
2009	21	6	22	17	16	8
2013	20	7	19	10	15	8

non-EU countries use investment subsidies and tendering to the same extent. The differences regarding the intensity of use of other instruments (TGCs and loans) are small. In contrast, there are significant differences with respect to two instruments: FITs/FIPs and tax incentives. The EU countries use comparatively more FITs but tax incentives appear to be less common. Therefore, there are some differences in policy combinations in the EU with respect to those in other non-EU high-income countries.

What is a plausible evolution of RES-E support combinations in the EU? In view of the above, the continuation of some trends is likely. These are not only related to changes in the instruments being part of the combinations, but also on the design elements of the instruments being combined.

More convergence of design elements within support schemes, mostly in FIT and FIP schemes, is likely, as cost-containment mechanisms, including capacity caps, generation caps and degression (whether traditional or flexible) are implemented. This trend may intensify with substantial RES-E penetration levels. It is even more difficult to predict future changes in the design of TGC schemes. Minimum TGC prices and banding (credit multipliers and carve outs)[4] will probably be implemented in order to mitigate two well-known problems of this instrument: uncertainty for investors given the volatility of the TGC price and lack of incentives to deploy the less mature technologies [1,39].

Increasing concern about the costs of support, the need to integrate an increasing share of RES in electricity markets and the higher maturity of renewable energy technologies such as wind on-shore makes it likely that there will be a move towards more "market-based" instruments, which in the European Commission jargon means tenders and FIPs. Tenders will progressively be used as a way to set support levels. And countries with FITs are likely to shift to FIPs, given their alleged benefit in terms of allowing a greater exposure of RES-E generators to market signals [6]. FIPs oblige renewable energy producers to find a seller for their production on the market and make sure that market signals reach the renewable energy operators through varying degrees of market exposure.

Recent documents from the European Commission suggest that these trends will continue in the near future. The European Commission Guidance for the Design of Renewables Support Schemes published on November 5th 2014 [6] argues that RES-E support instruments should adjust support levels to the costs of renewable energy technologies. Costs to the consumers should be reduced and overcompensation and excessive demand for new installations should be avoided. Instruments should be market-based, avoiding the problem of asymmetric information and reducing the risks of regulatory instability for investors. The document explicitly argues in favour of auctions for RES.

The Communication from the Commission on January 22nd 2014 on a policy framework for climate and energy in the period from 2020 to 2030 [11] states that national support schemes need to be rationalised to become more coherent with the internal market, more cost-effective and provide greater legal certainty for investors. Subsidies for mature energy technologies, including those for renewable energy, should be phased out entirely in the 2020–2030 timeframe.

Most importantly, the Guidelines on State aid for environmental protection and energy 2014–2020 [12] mention that market-based instruments, including competitive bidding processes but also FIPs, should gradually replace existing renewable support schemes from 2015 onwards. Those instruments are expected to increase cost-effectiveness and mitigate the distortions on competition. Competitive auctions will have to be implemented in order to provide support to all new installations from 2017 onwards.

However, the well-known limitations of tenders to promote less mature technologies and to encourage the participation of smaller actors (see [38,39]) suggest that tenders for mature technologies and large-scale plants will coexist with other instruments which are more favourable for those technologies and actors, such as a FITs and secondary instruments (e.g., investment subsidies). For example, in Italy, a tender scheme for large-scale power plants coexists with FITs for smaller-scale applications. The aforementioned European Commission Guidelines on State Aid also suggest that this may be a typical combination in the future since it envisages some exceptions to the use of auctions: (1) small installations or technologies in an initial stage of development[5]; (2) that MS could show that auctions would lead to a non-satisfactory outcome because they only promote a few projects or sites, because they would result in higher support levels or because they would be ineffective.

Regarding the secondary instruments, given the current economic crisis, and the need to control public deficits and, thus, the need for fiscal consolidation and fiscal austerity in many Member States, we are likely to see fewer instruments which have been traditionally linked to the public budget, such as tax incentives, at least in the short term. This might also be the case with soft loans and investment subsidies. Indeed, Table 2 shows that this has been a recent trend during the last years. However, this trend might be reversed as 2020 is approached if countries realise that they are unlikely to comply with their RES-E Directive targets, which may require the implementation of supplementary instruments.

Compliance with the 2020 Renewable Energy Directive [10] targets effectively and cost-efficiently involves the removal of all types of barriers (financial in our paper, but others as well, including the costs of grid access and administrative procedures). Combinations of instruments contribute to remove different types of barriers, not least because they are likely to reduce the regulatory risks for RES-E investors (since the impact of abrupt changes in one instrument is potentially less damaging). However, as mentioned above, combinations need to be very wise in the sense that the instruments being combined need to be coordinated in order to keep the overall costs of RES-E support within reasonable levels.

4. Concluding remarks

The literature on support schemes for RES-E has focused on the comparison between two primary instruments, feed-in laws and quotas with tradable green certificates. In contrast, not much attention has been paid to the combinations of those primary

[4] Banding can be implemented through carve-outs or through credit multipliers. Under carve-outs, targets for different technologies exist, leading to a fragmentation of the TGC market, with one quota for the mature and another for the non-mature technologies. Under credit multipliers, more TGCs are granted per unit of MWh generated for immature technologies compared to mature technologies [1].

[5] According to the Guidelines, small renewable energy installations are those with an installed electricity capacity of less than 1 MW. The threshold for wind plants is 6 MW.

Table 4
RES-E policy combinations in EU with respect to other non-EU high-income countries (2013).
Source: Own elaboration from [9].

	FIT/FIP	RPS with TGCs	Investment subsidies	Investment excise or other tax credits	Loans	Tendering
Non-EU[a]	3	4	7	7	7	3
Non-EU relative[b]	33%	44%	77%	77%	77%	33%
EU	20	7	19	10	15	8
EU relative[b]	80%	28%	76%	40%	60%	32%

[a] Non-EU high-income countries include Australia, Canada, Israel, Japan, New Zealand, Norway, South Korea, Switzerland, and United States.
[b] Relative=ratio of the number of instruments divided by the number of countries in either the non-EU (9 countries) or the EU category (25 countries).

instruments with other secondary instruments for RES-E support. This paper has reviewed the combinations of those instruments in the EU, using different data sources.

It has been shown that those combinations are common in the EU Member States. The most frequent mixes of instruments are between FITs and FIPs, on the one hand, and investment subsidies, tax incentives and soft loans on the other. However, significant differences in the details of those combinations across countries exist. We should move beyond the feed-in laws vs. TGCs vs. tender discussion and even more beyond the TGCs vs. feed-in laws dichotomy and have an integrative view of support schemes, taking all the instruments into account, i.e., including secondary instruments, since the RES-E policy landscape in the EU is one characterised by those combinations of instruments.

There have been some changes in the policy mix between primary and secondary instruments in the last decade, mostly related to changes in the primary instruments themselves. Combination of primary instruments is a common trend recently. Quotas (in the form of capacity caps) have been implemented in FITs and support levels in FITs have sometimes been set through tenders. A shift from FITs to FIPs and from FITs to/with tenders can be observed. In countries with quotas with TGCs, FITs or FIPs have been used as alternative systems for specific technologies or small projects. Countries with FITs have increasingly used cost-containment design elements such as capacity caps and budget caps. Convergence relates more to the design of the instruments rather than to the common application of a certain type of instrument. Some convergence between the design elements of primary instruments can be observed, leading to the convergence of support schemes. Several EU documents suggest that a move towards more "market-based" schemes, and particularly to tenders, is likely in the short and medium terms. However, these schemes will still need to be combined with other instruments, both primary (FITs) and secondary (investment subsidies), given their potential limitations to promote less mature technologies or to encourage the participation of smaller actors.

In view of the information from the different data sources [24,25,30–32], exclusion and explicit coordination of support of primary and secondary instruments do not seem to be a common element in the policy combinations in the EU. This suggests that, in order to have a robust, coherent policy mix which is effective in deploying RES-E without financially overburdening consumers, instruments should be combined in a coordinated manner.

Several avenues for future research can be foreseen. First, the rationale for the aforementioned combinations has not been analysed in detail. Policies for renewable energy are generally justified in the EU Member States on the basis of their alleged contribution to the correction of market failures and a "sustainable energy system", i.e., security of supply (reduction of fossil-fuel imports), environmental protection (decarbonisation) and a competitive energy system (reasonable energy prices) (see, for example, [40,41]). Notwithstanding, it is extremely difficult to identify the "real" rationales in different countries. There are government goals mixed with political economy factors (i.e., the influence of lobby groups) behind them. This would involve a detailed analysis which is clearly beyond the scope of this paper, although it is certainly a fruitful avenue for further research. On the other hand, as already mentioned in the text, empirical analysis of the effectiveness and efficiency of the combinations of RES-E support policies (for the same technology) with respect to the use of a single instrument is absent, with the exception of [7]. As argued by [4], further empirical research is needed to fully understand the effectiveness and efficiency of combinations of policy instruments designed to achieve a very high share of RES-E in the long term. Case studies for selected countries on the performance of those instrument combinations should be carried out. Finally, there should be more focus on the analysis of the likely directions of combinations of instruments for RES-E support in the future.

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